CHAPTER V

DISCUSSION

Effect of spacing:

Population density of plants per unit of land area is an important factor which affects the growth and yield characters and ultimately the grain yield of crops. In this experiment three row spacings (15 x 10 cm, 25 x 10 cm, 35 x 10 cm) were included. The optimum spacing which recorded the highest seed yield per unit area was found to be 25 cm between rows and 10 cm between plants in the rows. This spacing resulted in a population density of 400,000 plants/hectare and provided an area of 250 sq. cm for each plant. The second highest seed yield was obtained from the closest spacing of 15 cm x 10 cm, corresponding to a population density of 666,000 plants/hectare. The lowest seed yield was associated with the widest spacing of 35 cm x 10 cm, corresponding to a density of 286,000 plants/hectare. The lowest seed yield in the widest spacing may be attributed
to the lowest plant population density, because the major yield attributes such as no. of pods, no. of seeds and mean weight of seeds per plant are found to be near equal to those plants grown under $s_2$ (25 cm x 10 cm.) spacing. The highest test weight of seeds obtained under widest spacing could not compensate the low plant population density. On the other hand, in close spacing of 15 cm x 10 cm., the mean no. of seeds and weight of seeds per plant are found to be much lower than the other two spacings. Even then the closest spacing with a higher population density could yield high seed weight per unit of land. The $s_2$ spacing with a medium plant population revealed uniformly high no. of seeds and weight of seeds/plant together with a high test weight of seeds. Therefore, even with a lower plant population $s_2$ spacing (25 cm x 10 cm.) ultimately recorded the highest seed yield per unit of land.

The significant interaction between the varieties and spacings indicates that the varieties perform differently under the three spacings. Thus it is seen (Table No.1.6) that varieties PIMS-1 and Kopergaon recorded highest seed yield in $s_2$ (25 cm x 10 cm.) spacing, but T-44 and PS-16 produced respectively higher seed yield in the closest spacing of $s_1$ (15 cm x 10 cm.). This has a practical implication regarding the choice of variety to be selected for sowing. In the case of T-44, 15 cm x 10 cm. spacing will give the highest yield; but in the case of Kopergaon,
S₂ (25 cm x 10 cm.) spacing will produce the highest seed yield per unit of land. The differential behaviour of these two varieties to spacings may be correlated to the architectural differences in the morphology of T-44 which is a compact short statured plant and can naturally accommodate more no. of plants per unit of land. On the other hand, variety Kopergaon is a vigorous open statured plant requiring more space.

Reddy and Singh (1981) have reported that closest row spacing of the summer moong gave the highest seed yields. Similar reports have also been published by Giri et al (1981) in v. mungo and Singh, Singh and Gupta (1981) in field pea. Yield differences in different varieties under different spacings have also been recorded by Bhat (1981) in cow pea.

**Varietal Performance:**

The four varieties of greengram selected in this investigation are PMS-1, T-44, Kopergaon and RS-16. The traditional sowing time of this crop in Assam is in the first fortnight of September. The performance of these four varieties clearly shows that T-44 and Kopergaon produce the highest seed yield per unit of land during this season. The difference between these two varieties is not found to be statistically significant. The high seed yield of these varieties can be attributed to better vegetative growth
together with the major yield attributes such as the number of pods, seeds, weight of seeds/plant and test weight of seeds. A close scrutiny of the yield attributes of these two varieties show some interesting variations, not with standing the near equal yield of seeds. Thus it is seen that mean no. of pods, seeds and seed weight per plant is found to be higher in variety T-44 than the corresponding values in Kopargaon. But the test weight of seeds is very high in Kopargaon (47.01 to 48.4 gm), as compared to T-44 (34.66 to 38.85 gm). Therefore, it appears that the deficiency of some of the yield attributes in Kopargaon is compensated by higher test weight of seeds and this has resulted in near equal grain yield in both the varieties. The harvest index is a measure of the photosynthetic efficiency of a given plant. It expresses the seed yield as a percentage of the total biomass of the whole plant. In this respect Kopargaon tops the list (45.7%) followed by T-44 (42.8%). The bold seeds of Kopargaon, in comparison to T-44, makes this variety more attractive and as such, it is likely to fetch better market price. As regards the grain yield per day per hectare PS-16 topped the list with 41.882 kg followed by T-44 (37.652) during the post-monsoon season while in the pre-monsoon season PMS-1 recorded the highest grain yield per day/ha (25.684 kg) followed by PS-16 (25.636 kg). The performance of the four varieties during the non traditional season (February to May) shows a different picture in contrast to the performance during the traditional
season, it is seen that variety PIMS-1 topped the seed yield per unit area closely followed by PS-16 and T-44. But Kopergaon recorded the lowest yield during the February-March sowing. The poor performance of Kopergaon can be directly attributed to the very low number of seeds/plant as compared to the other three varieties. Even the high test weight of seeds of this variety has not helped it in making up the poor seed yield per unit of land. The fact that the harvest index of Kopergaon is one of the lowest (38.033 gm) confirms it and indicates that the weather conditions prevailing during the pre-monsoon season adversely affects the vegetative and reproductive growth of this variety, despite of its high genetic potential. Therefore, it appears from the results that variety Kopergaon is suitable for cultivation exclusively during the traditional season (September - December). The performance of T-44, on the other hand, is encouraging due to the fact that this variety gives near equal seed yield as that of PIMS-1 and PS-16, and the difference is not found to be statistically significant. Thus it may be observed and finally concluded that the variety T-44 is equally suited for cultivation during both the seasons, unlike the variety Kopergaon. The other two varieties PIMS-1 and PS-16 may also be selected for sowing during the non-traditional season. In this context it may be mentioned that only two varieties (T-44 and Kopergaon) were included in the last two experiments due to their consistently higher grain yield during the traditional season.
Choudhury (1981) reported that T-44 produced higher average seed yields/ha than the CV. 12/133 during summer season.

Singh et al (1980) while summarising the work on four vigna radiata cultivars, reported that there was no significant difference in seed yield among them.

**Effect of sowing date (during the non-traditional season)**

One of the major objectives of this investigation was to find out the suitability of green gram as a crop for cultivation during the summer season which is not a traditional growing season of this crop in the state of Assam. So the four varieties of green gram referred earlier were sown under three sowing dates (8th February, 23rd February, and 10th March). The highest seed yield per hectare is associated with the first sowing (8th February) which is closely followed by the second and the third sowing respectively. First sowing showed only 5.3% more seed yield than the third sowing. The harvest indices under the three sowing dates do not differ significantly as in the case of the yield of seed. All the vegetative and reproductive characters also fail to produce any significant differences due to the three sowing dates. It appears, therefore, that green gram may be profitably sown in this region any time between the first week of February to the first week of March.

The significant interaction between the sowing dates and varieties on the grain yield indicates that there
is differential performance of the varieties under the three
sowing dates. The interaction\(^{(b)}\) (Table 2.5(b) yield of seeds/
plot) shows that PIMS-1 and Kopargaon record low seed yield
with the delay in the sowing dates from \(S_1\) (first sowing)
to \(S_3\) (third sowing). Similar report has been made by
Choudhury \((1981)\) in greengram. On the other hand, T-44 and
PS-16 show a diametrically opposite behaviour with the
seed yield increasing with the delay in sowing dates.
Paroda and Sing \((1980)\) also reported differential varietal
behaviour of pigeon pea under different sowing dates. This
finding is of considerable significance and it may be
successfully utilized in selecting appropriate varieties
of greengram for sowing early or late in the season. From
this investigation PIMS-1 appears to be the most suitable
variety for sowing in the month of February. But the most
suitable variety for sowing in March is PS-16 which is
closely followed by T-44. The early sowing of greengram in
the first week of February required 7 days more to attain
maturity than the other two later sowing dates. Yield
differences in different varieties under different sowing
dates have been reported by Bhosale and Ardhale \((1979)\)
in moong beans, Singh et al \((1980)\) in vigna radiata,
Saharia \((1980)\) in lentil, Pandey \((1981)\) in vicia faba and
Melhoranca and Mesquita \((1982)\) in soybean.
Effect of fertilizer mixture and methods of application:

Four NPK fertilizer mixtures were applied to the greengram crop under two methods of application, namely furrow application and broadcast methods of application. Among the four fertilizer mixtures F_4 (80 kg N+80 kg P+80 kg K/ha) produced the highest seed yield closely followed by the mixture F_3 (80 kg N+80 kg P+40 kg K/ha). But the difference in seed yield between these two mixtures was not statistically significant. The lowest yield (1583.9 kg/ha) was associated with F_1 mixture (40 kg N+40 kg P+40 kg K/ha).

The F_2 mixture (40 kg N+80 kg P+40 kg K/ha) yielded significantly more grain than the F_1 mixture. The performance of greengram under different fertilizer mixtures clearly shows that the addition of P_20_5 results in more seed yield than without phosphate application. Similar reports have been stated by Panwar and Singh (1981) in vigna radiata. Similarly the application of nitrogen at the rate of 80 kg/ha in association of 80 kg P_20_5/ha has resulted in further increase in the grain yield of this crop. Similar report has been recorded by Pezez (1979) in phaseolus vulgaris.

On the other hand, addition of potash beyond 40 kg/ha does not produce any significant additional grain. The beneficial effects of phosphorus as well as nitrogen is clearly visible in the dry weight of shoot as well as the no. of pods and seeds/plant. But the test weight of seeds has not changed markedly due to the application of additional NPK. The fact
that harvest indices associated with $P_2P_3$ and $P_4$ mixtures are more than $P_1$ mixtures, clearly shows that higher levels of NP fertilizer mixtures induce efficient photosynthetic utilization of the applied nutrients for the production of grains. The ineffectiveness of the applied potash on the seed yield of green gram is further highlighted by the fact that it shows depressing effect on the grain yield. Thus it is observed that the seed yield is reduced from 2384.3 kg/ha with 40 kg $P_2O_5$ alone to 1951.0 kg/ha with 40 kg each of $P_2O_5 + K_2O$ applied together. A perusal of the soil analytical data of the experimental soil indicates that it is rich in available potash. So it appears that the application of additional potash beyond 40 kg/ha is not only unnecessary but is positively damaging to the yield of green gram under agro-climatic conditions of Assam. The beneficial effects of phosphorus on the yield of peas have been established by Sen and Sundara Rao (1948), Müncheisen (1951), Sarmah and Misra (1961). Again Moolani and Jana (1965), Prasad et al (1968) and Upadhyay (1968) have reported a positive response of legumes to the application of phosphorus. Similar findings have also been reported by Sahu (1966) in moong and vasimalai and Subramanian (1980) in green gram. Nuttika (1979) and Perez (1979) reported more seed yield with NPK application and less without NPK, in phaseolus vulgaris.

Regarding the methods of application, it is found that furrow placement has resulted in an increased seed yield
of 26.7% over the broadcast method. This is a substantial increase and is statistically significant. These findings have a practical implication in that the applied fertilizers are more efficiently utilized by furrow placement than broadcast. Though the cost of furrow placement of fertilizers may be more than the broadcast method, the additional grain yield will more than compensate the greater cost incurred. In other words, a lower level of fertilizer mixture can produce higher seed yield by furrow placement as compared to broadcast application of a higher dose of fertilizer mixture. The findings indicate that the highest grain yield (2191.3 kg/ha) produced under broadcast method of application required the fertilizer mixture F₄ with variety T-44. On the other hand, the variety remaining same (T-44) furrow placement of F₃ mixture resulted in a seed yield of 2304.0 kg/ha. Therefore, there is considerable scope for fertilizer economy by practising furrow placement of the mixtures in the cultivation of greengram.

**Effect of rhizobium culture**

The overall increase in the seed yield of greengram due to the rhizobium culture is found to be 22.1% more than the control (without culture). A perusal of the growth and yield attributes vividly brings out the fact that no. of pods/plant, no. of seeds/plant, mean weight of seeds/plant and finally the test weight of seeds are favourably affected by the rhizobium treatment. This has manifested itself in
increased seed yield of this crop due to the treatment with rhizobium culture. This is to be expected in view of the nitrogen fixed by the symbiotic bacteria present in the rhizobium culture. (An eye observation of the size and number of nodules of the greengram plant has been recorded with rhizobium and no rhizobium culture and is shown in Table 4.6). Even though the experimental soil was acidic in reaction (PH 5.6) the rhizobial flora appears to have functioned normally. The differential behaviour of the four fertilizer mixtures, under the two rhizobium cultures is noteworthy. Thus it is seen that the highest seed yield in the treatment with rhizobial culture is associated with the $P_1$ mixture ($0 \text{ kg N} + 40 \text{ kg P} + 0 \text{ kg K}/\text{ha}$). Similar findings have been reported by Prasad and Sanoria (1981) in bengalgram (chick pea).

In the absence of rhizobium culture, $P_4$ mixture ($40 \text{ kg N} + 40 \text{ kg P} + 40 \text{ kg K}/\text{ha}$) recorded the highest seed yield. But the $P_4$ mixtures in presence of rhizobium culture gives the lowest seed yield. From this it may be inferred that the applied rhizobium culture benefits the greengram plant even when a low grade fertilizer mixture or no fertilizer mixture is applied. Thus the beneficial effects of rhizobium culture on greengram is quite evident. Pareek (1978) reported that greengram inoculated with rhizobium culture showed 50% increase in grain yield. Similar reports have been published by Bhatnagar & Jouhari (1979) in vigna radiata and soybean; Sarmah, Reddy and Saxena (1981) in gram, lentil pea, cowpea, moth, ward, mung and arahar. Subba Rao (1982) has also
reported that moong bean (Vigna radiata) inoculated with rhizobium culture at different locations showed 22.55% increase of grain yield. Therefore, there is considerable scope for fertilizer economy by the use of rhizobium culture on greengram.

Effect of irrigation:

The non-traditional cultivation of the greengram crop during the summer months necessitated the inclusion of irrigation treatment in order to find out the beneficial effects, if any, on this crop plant. Fifteen days after sowing, when the crop was well established, the irrigation treatments were commenced once in every 10 days. The control plot did not receive irrigation. In all, four irrigations were given. The results indicate that the seed yield due to the irrigation was not statistically significant as compared to the control treatment. The ineffectiveness of the irrigation treatment on the growth and yield of green-gram may be attributed to the well distributed pre-monsoon rain received during the experimental period. A scrutiny of the meteorological data presented (Table No.II) shows that the crop received uniformly well distributed rainfall during its growing period and as such it nullified the beneficial effects usually associated with irrigation. "Norwester" rainfall is a common climatic feature in Assam and these rains, though erratic, help considerably in supplying water
to soil during the pre-monsoon period extending from the month of February to the end of May. The rate and the frequency of this localized rainfall goes on increasing from February to May and ultimately merges with the southwest monsoon which usually breaks in the first fortnight of June. As a result, the need for irrigation is usually not felt by the farmers of this region. So a short crop like green gram can successfully and profitably be grown during the pre-monsoon season without the assistance of irrigation water. This is favourable from the point of view of economy in the cost of cultivation of green gram as a pre-monsoon pulse crop.

Thus, there is considerable potential to grow this crop without irrigation in the fallow lands of Assam, as a profitable catch crop, before the start of the south west monsoon rains.

Economics of Cultivation:

The acceptance of any improved technology in agriculture mainly depends on the net profit obtained from a unit of land. Therefore, the cost of cultivation of the green gram crop under different treatment combinations has been worked out in order to focus the profit or loss expected from it. A perusal of the table of cost of cultivation of green gram (Table No. XXI) shows that the highest net profit per hectare of Rs. 5287.86 can be obtained from the variety
Kopergaon receiving the F₃ mixture (80 kg N+80 kg P+40 kg K/ha) applied by furrow placement during the traditional post-monsoon season. The second highest net profit of ₹4725.18/ha may be obtained from the variety Kopergaon receiving the fertilizer mixture F₄ (40 kg N+40 kg P+40 kg K/ha) applied by furrow placement. Among the treatments in which the fertilizer mixture was applied by broad casting, the highest net profit/ha of ₹3944.76/ha is obtained from the variety T-44 in association with the F₄ mixture (80 kg N+80 kg P+80 kg K/ha). The second highest profit in the broad cast method of fertilizer application is found to be ₹3587.38/ha in the variety T-44. From the above observations it may be concluded that varieties Kopergaon followed by T-44 are the two most suitable and profitable greengram varieties for cultivation during the traditional post-monsoon season in the Agro-climatic conditions prevailing the Guwahati region of Assam. Besides, it is also worth noting that application of NPK mixtures by furrow placement is most profitable. However, broadcast application of fertilizer mixtures has also proved to be profitable though a little less than the furrow placement.

The overall effect of rhizobium culture treatment is found to be 22.1% more grain yield than without rhizobium treatment. The actual increase in yield is found to be 400 kg/ha, at ₹3.00/kg, the nett additional profitability per hectare works out to be ₹1200.00 due to the rhizobium
treatment alone. Therefore, the use of rhizobium culture in greengram will be profitable and as such this practice should be encouraged.

A perusal of the table of cost of cultivation of greengram in the pre-monsoon season (non-traditional) shows that the highest net profit per hectare of Rs. 5086.40 can be obtained from the variety PS-16 under third sowing (10th March). The second highest net profit of Rs. 4947.80 per hectare is obtained from the variety PMS-I under the second sowing date (23rd February).

Productive potential: The discussion made so far, indicate that a grain yield of 3515.3 kg/ha can be harvested during the traditional crop season by using variety Kupergaon coupled with appropriate spacing and fertilizer mixture. During the non-traditional season a maximum yield of 2206.7 kg/ha can be harvested by using the variety PS-16. Thus if greengram is cultivated during both the traditional and non-traditional seasons, the productive potential of this crop can be raised to 5722 kg (3515.3 kg + 2206.7 kg)/ha per year within a combined crop duration of less than 140 days. The net return from the two crops of greengram in a year will amount to over Rs. 10,000/ha per year (Rs. 5287 + Rs. 5035) respectively. From this it may be clearly seen that the greengram crop, even though a short duration one, has high yield potentiality together with large profit margin. Besides the two crops of greengram, the farmers of this area can grow a third crop having a crop duration over 100 days. Greengram being a leguminous plant will also help in fixing atmospheric nitrogen and thereby help to maintain the soil fertility.